DOCTOR
OF
PHILOSOPHY

SYSTEM INTERDICTION AND DEFENSE

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The problem of interdicting components of an adversary's systems were studied, e.g., a war-time economy, a transportation network, etc. Basic techniques are developed and illustrated with a simple network interdiction problem, "maximizing the shortest path" (MXSP). In MXSP, an interdictor wishes to employ limited interdiction resources as effectively as possible to slow an adversary in moving between two network nodes. "Interdiction" destroys a network arc entirely or increases its effective length through an attack. This bi-level, max-min problem is formulated as a mixed-integer program (MIP), but unique decomposition algorithms are developed to solve the problem more efficiently than standard branch and bound. One algorithm is essentially Benders decomposition with special integrality cuts for the master problem. A second algorithm uses a new set-covering master problem, and a third is a hybrid of the first two. The techniques were extended (*i*) to solve general system-interdiction problems, some of which cannot be formulated as MIPs, (*ii*) to solve system-defense problems where critical system components must be identified and hardened against interdiction, and (*iii*) to solve interdiction problems with uncertain interdiction success. Computational experience were reported for MXSP, a shortest-path network-defense problem and MXSP with uncertain interdiction success.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Network, Interdiction, Defense, Benders Decomposition, Stochastic Programming, Set Covering

SOFT DECISION DIVERSITY CODED DIRECT SEQUENCE SPRED SPECTRUM DIFFERENTIAL PHASE SHIFT-KEYING SYSTEMS IN PULSE-JAMMED MULTIPATH-FADING CHANNELS

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The performance of a direct sequence spread spectrum system utilizing differential phase shift-keying modulation over a fading channel in the presence of pulse noise interference and additive white Gaussian noise is considered. Time and spatial diversity receivers utilizing various normalization schemes and post-detection selection combining are employed to overcome performance limitations inherent in certain adverse environments. Numerical results are presented over a range of environmental conditions demonstrating the efficacy of such receivers. The performance analysis is extended through the utilization of convolutional coding and soft decision Viterbi decoding. The performance of the maximum likelihood decoding operation is expressed in terms of an equivalent uncoded system

for both the Rayleigh and Rician fading channel with interference effects. Numerical results are then presented demonstrating the efficacy of such a receiver.

DoD KEY TECHNOLOGY AREAS: Electronics, Electronic Warfare

KEYWORDS: Wireless Communications, Direct Sequence Spread Spectrum, Differential Phase Shift-Keying, Convolutional Coding, Viterbi Decoding